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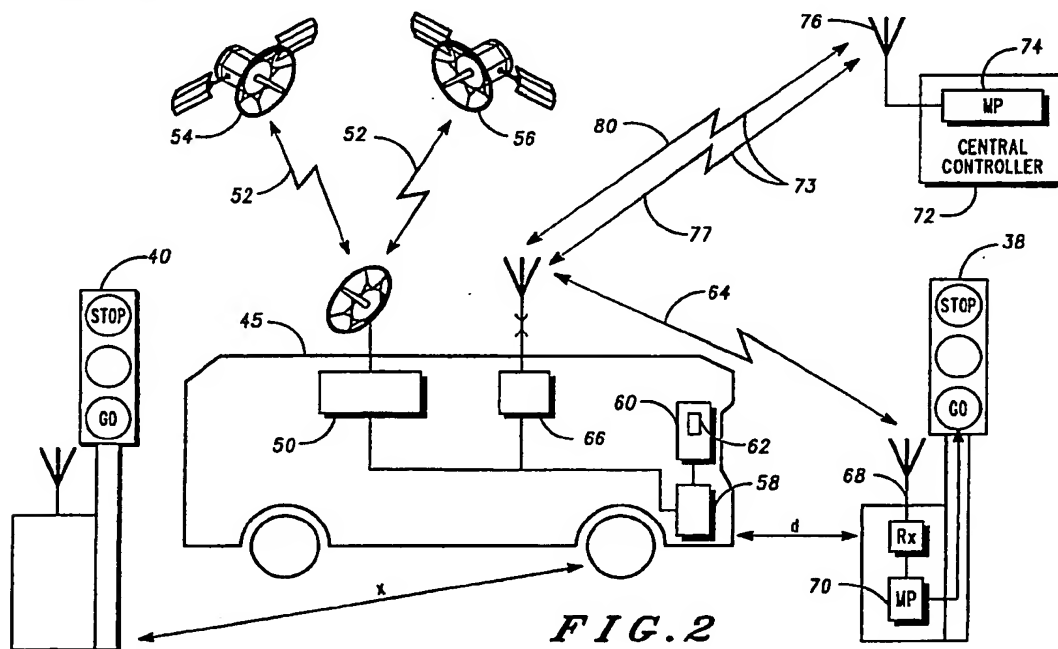
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(54) Traffic control

(57) Fig. 2 shows a system for the control of a vehicle travelling along a predetermined route. Control equipment, located in a vehicle 45, receives position and timetable information and thereby ascertains whether the vehicle is running to schedule. In the event that the schedule has been broken, the control equipment generates a correction signal 64 that is broadcast to a traffic control device 38 positioned on the predetermined route. The traffic control device, in response to the correction signal, re-schedules the vehicle to the timetabled information.



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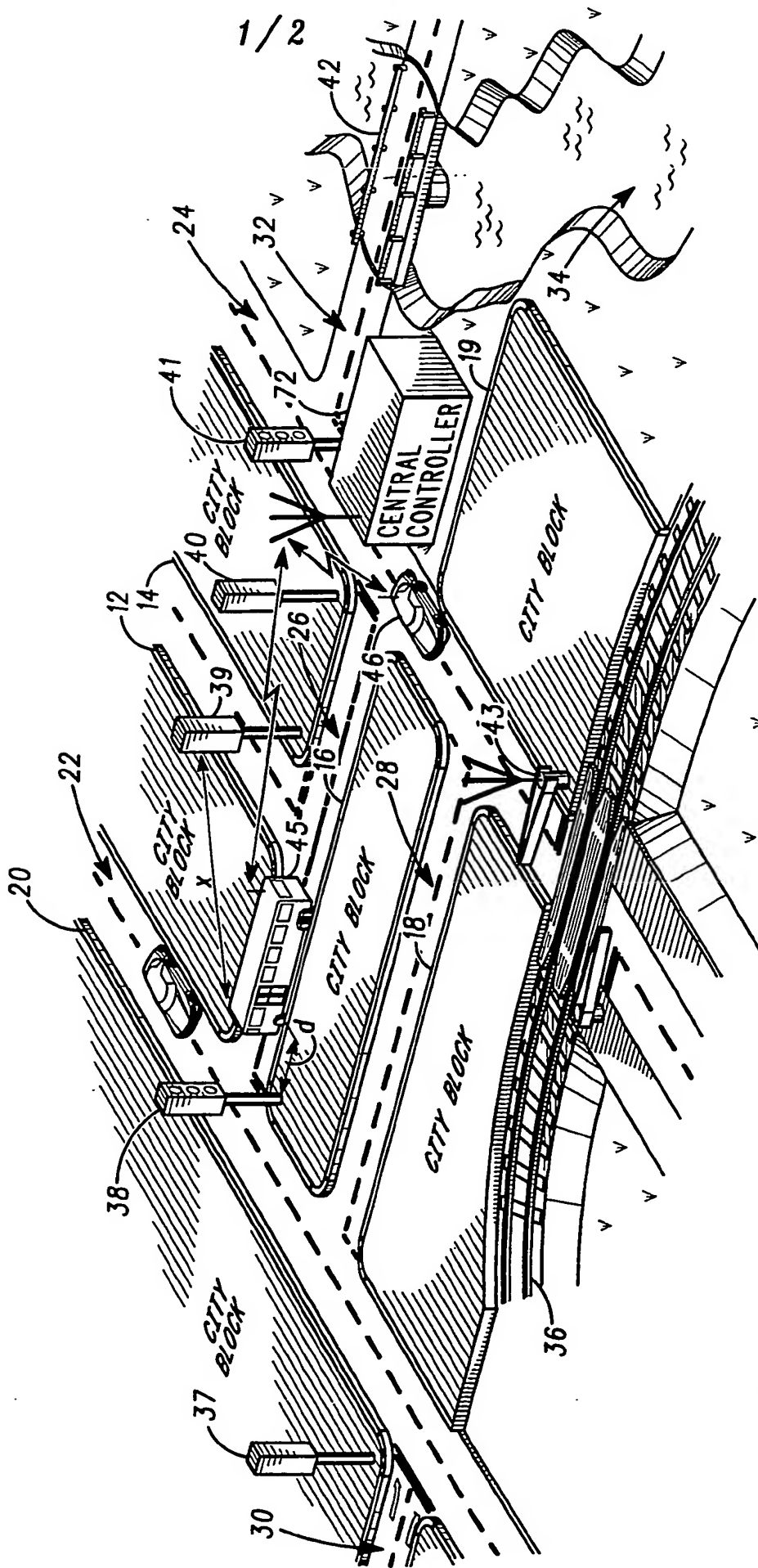


FIG. 1

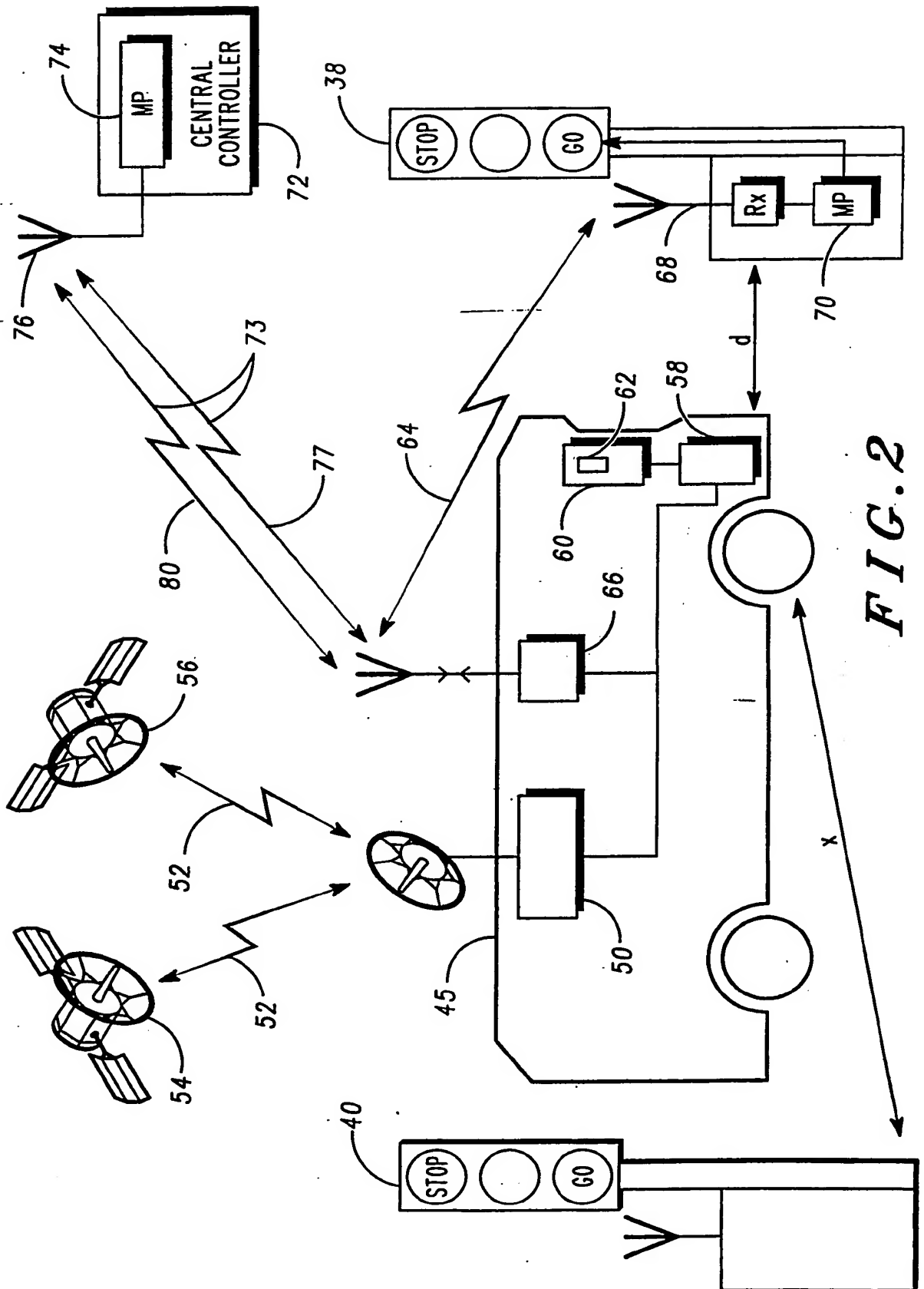


FIG. 2

A SYSTEM FOR CONTROL OF A VEHICLE AND  
A VEHICLE THEREFOR

Background to the Invention

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This invention relates, in general, to traffic control systems, and is particularly, but not exclusively, applicable to the scheduling of public vehicular transport services.

10 

Summary of the Prior Art

In some Metropolitan areas, public vehicular transport services, e.g. bus services, operate in conjunction with computer controlled traffic control devices, particularly traffic lights, to provide a scheduled service for the public. More specifically, present computer controlled systems comprise a number of transmitters located throughout the Metropolitan area that transmit information to passing vehicles. Each transmitter has its own unique address which, when received by a computer located in the bus, is used by the computer, in conjunction with a unique route program specifying a timetabled relationship for that address, to determine whether the bus is running on-time. If the computer determines that it is "out-of-time" in relation to a particular transmitter address, the computer flags that the bus is currently out-of-time and eventually communicates this fact to a central controller that controls the transport service in the Metropolitan area. More particularly, the central controller, which may be responsible for the control of up to 500 buses on a single communications channel, sequentially polls buses in the system to ascertain whether they are running to schedule. It is only after a bus has been polled by the central controller that a transmission identifying a current schedule is transmitted to the central controller. The central controller, in response to an out-of time message, instructs a traffic signal, typically coupled to the central controller through a wire line link, to alter its state either to advance the bus along the route by allowing it to proceed unhindered or to retard the bus at a stop signal, thereby substantially re-scheduling the bus to its timetable (route schedule).

35 Clearly, there is an unsatisfactory delay in transmission caused by the polling sequence and an associated delay arising from the inability of the

present system to re-schedule a vehicle immediately upon realisation that the vehicle is out-of-time.

As will be appreciated, such a traffic control system, although providing some modicum of scheduling benefit, is also inflexible because a computer, permanently located in the vehicle, requires re-programming if the bus is assigned to a route different from that for which the computer was originally programmed. In addition, installation of the computer in the bus is relatively expensive. Furthermore, if a new route through the Metropolitan area is required, there is a need to provide additional long-wave radio frequency transmitters along the new route, with each new transmitter being assigned a unique address. Moreover, since the central controller is responsible for the operational control of the traffic signals along the new route, these traffic signals must be hardwired, for example, to the central controller, which is both a costly and a time consuming process.

Additionally, although the system does provide for the rescheduling of a vehicle on route to compensate for lost time, the polling method employed by the central controller is time consuming and wasteful of communications resources, i.e. the communications channel, because each vehicle is required to transmit its present position and time.

It will be appreciated that there is a requirement in the art to provide an improved traffic control system which overcomes the aforementioned deficiencies.

#### Summary of the Invention

In accordance with the present invention, there is provided a system for control of a vehicle travelling along a predetermined route, comprising: a vehicle having: a first receiver for receiving position information identifying the position of the vehicle; an input device for receiving timetabled information about the predetermined route; means, responsive to the input device and the first receiver, for comparing the received position information with the timetabled information, for determining whether the vehicle is running to schedule and for generating a correction signal in the event that the vehicle is not running to schedule; and a transmitter for transmitting the correction signal; and a traffic control device positioned on the predetermined route, comprising: a receiver for receiving correction signals; and a controller, coupled to the receiver, for operational control of the traffic device in

response to correction signals to re-schedule the vehicle to the timetabled information.

In a preferred embodiment, the correction signal is transmitted when the vehicle is approaching and in proximity to the traffic control device. The  
5 correction signal may also be transmitted at a low power.

The system may further comprise a central controller having: means for generating and transmitting interrogation signals to the vehicle; and receiver means for receiving signals transmitted from the vehicle; and the vehicle may further comprise: a second receiver responsive to the  
10 interrogation signals; and means, coupled to the receiver, for generating an information signal containing time and location information for the vehicle; wherein the transmitter transmits the information signal to the receiver means of the central controller, thereby providing the central controller with the time and location information.

15 The central controller may poll a plurality of vehicles with the interrogation signals. Furthermore, the correction signal and information signal may be transmitted on a common channel at relatively low power and relatively high power respectively.

In the preferred embodiment, the first receiver is a GPS receiver, the  
20 traffic control device is one of an automatic barrier, a bridge, a pedestrian crossing and a traffic light, with the input device being a smartcard reader and the timetabled information being contained on a smartcard.

In a further aspect of the invention, there is provided a vehicle having: a receiver for receiving position information identifying the position of the  
25 vehicle; an input device for receiving timetabled information about a predetermined route along which the vehicle is to travel; means responsive to the input device and the receiver for comparing the received position information with the timetabled information, for determining whether the vehicle is running to schedule and for generating a correction signal in the  
30 event that the vehicle is not running to schedule; and a transmitter for transmitting the correction signal to a traffic control device positioned on the predetermined route.

In an alternative embodiment, the correction signal is transmitted at a low power and in proximity to a traffic control device such that interference  
35 from the transmission of the correction signal is minimised.

An exemplary embodiment of the present invention will now be described with reference to the accompanying drawings.

### Brief Description of the Drawings

Fig. 1 shows a traffic control system in accordance with the preferred embodiment of the present invention.

5 Fig. 2 illustrates a portion of the system of Fig. 1 in greater detail.

### Detailed Description of a Preferred Embodiment

Referring to Fig. 1, there is shown a system for the control of a vehicle  
10 travelling along a predetermined route constructed in accordance with a preferred embodiment of the present invention. In the illustration, a Metropolitan area 10 comprising a number of city blocks 12-20 with a number of traffic routes 22-36, e.g. roads 22-32, rivers 34 and railways 36, running along and between the city blocks 12-20. At the intersections of  
15 some of the traffic routes, there are located traffic control devices 37-43 that regulate the flow of traffic along those traffic routes. The traffic control devices 37-43 may be, for example, traffic lights 37-40, pedestrian crossings 41, swing bridges 42 or automatic barriers 43. Vehicles, such as buses 45, 46, travel along the traffic routes and are able to selectively alter a nearby traffic  
20 signal as the vehicle 45, 46 approaches that traffic signal through the transmission of a control signal thereto.

With reference to Fig. 2, the system for the control a vehicle travelling a predetermined traffic route is shown in greater detail. A vehicle 45 for which it is desirable to run to a timetable, such as a public transport bus,  
25 comprises a global positioning by satellite (GPS) receiver 50 that is receptive to timing and positional signals 52 transmitted from GPS satellites 54, 56 located in earth orbit. The GPS receiver 50 is coupled to a microprocessor 58 which decodes and interpretes the timing and positional information 52. A smartcard reader 60 is receptive to a smartcard 62 that contains time-tabled  
30 information defining a predetermined route schedule for the bus. The smartcard reader is coupled to the microprocessor 58. In response to receiving positional and timing information 52 from the GPS orbiting satellites 54, 56, the microprocessor 58 determines whether the vehicle is running to schedule through comparison of the positional and timing  
35 information 52 with the time-tabled information contained on the smartcard 62. If the microprocessor determines that the vehicle is not running to schedule, the microprocessor generates a correction signal 64 which is

eventually transmitted, at low power, through a transmitter 66 located on the vehicle 45. The correction signal 64 is received by a receiver 68 of a traffic control device 38, such as traffic light. A microprocessor 70, located within the traffic control device 38 interpretes the correction signal 64 and  
5 alters the traffic signal accordingly. More particularly, if the vehicle is delayed and the traffic device is currently delaying the vehicle, the microprocessor 70 instructs the traffic signal to change to a go position, thereby allowing the vehicle to gain time and re-align itself with the time-tabled schedule. Alternatively, if the bus is running ahead of schedule,  
10 a correction signal 64 may be transmitted from the vehicle instructing the traffic control device to delay the vehicle by the appropriate length of time.

A central controller 72, typically located in the Metropolitan area 10, maintains contact with a plurality of vehicles operating in the system through the use of a radio frequency link 73. The central controller 72  
15 comprises a microprocessor 74 for the operational control of the central controller and a transceiver 76 allowing the central controller to communicate with vehicles 45, 46 in the system. The microprocessor 74 of the central controller 72 periodically generates an interrogation signal 77 that is transmitted in sequence to all the vehicles in the system 10, i.e. the  
20 central controller 72 polls the vehicles. As will be appreciated, in order to poll a number of buses in the system, the interrogation signal must be individually addressed to each one of those buses. This may be achieved, as will be understood by one skilled in the art, through the use of a unique address allocated to each bus, whereby the address is transmitted in the  
25 interrogation signal 77. In the preferred embodiment, the interrogation signal 77 is transmitted on a single channel common to all vehicles on the system.

Each vehicle further comprises a receiver for receiving the interrogation signals 77. The microprocessor 58 of the vehicle, in response to  
30 these interrogation signals 77, determines from the received position and information signals 52 whether the vehicle is on schedule. If the vehicle is running on schedule, there is only a requirement to transmit a very short burst signal 80 acknowledging the fact that the bus is on time, otherwise position and time information may be transmitted back to the central  
35 controller. In this way, there is a reduction in the transmission time required to poll all the vehicles in the system, which may number 500 or more, thereby saving channel usage by an estimated 80%. The anticipated

channel usage results from the expectation that, at any one time, only ~10% of buses within the system will be running "out-of-time", i.e. not to schedule. Clearly, since more channel capacity is available, more buses may be controlled using a single control channel.

5           In a preferred embodiment, the frequency of the control channel and the frequency at which a vehicle, e.g. a bus, broadcasts to a traffic control device 37-43 is the same. In this case, a common transmitter 66 is used to communicate with the traffic control devices and the central controller 72. Furthermore, in order to limit interference with other traffic control devices  
10       which operate on the same frequency, the signal is transmitted at low power thereby minimising interference. In the preferred embodiment, the bus only transmits the correction signal 64 when it is in proximity to a traffic control device 37-43 that it wishes to alter. The vehicle transmits the correction  
15       signal 64 when it is a distance  $d$  from the traffic control device 38, whereby the signal does not effect any other traffic control device located at distance  $x$  ( $x > d$ ) away from the vehicle.

          Alternatively, the smartcard may contain information which uniquely identifies a traffic control device, whereby this information is encoded in the correction signal 64. In this way, each traffic control device can be uniquely  
20       addressed, as will be understood by one skilled in the art.

          An invention so designed and described produces novel advantages of a system for controlling the movement of traffic in a Metropolitan area which requires no wireline links between a central controller and traffic control devices located in the area. Furthermore, through the implementation of  
25       smartcard technology, greater flexibility is achieved. Specifically, any suitable vehicle, e.g. a bus, can operate on any predetermined route by simply using a smartcard programmed with the appropriate route and schedule. In addition, new routes can be implemented with minimal additional infrastructure, i.e. for a new route each traffic signal on that new  
30       route solely needs to be receptive to transmitted correction signals. The invention also provides for a reduction in the number of computers required within buses, with any associated reduction in cost therefor. Additionally, the invention eliminates any delays associated with the prior art polling methodology ultimately used to control traffic signals along each route.

35       It will, of course, be understood that the description has been given by way of example only and that modifications in detail, such as the use of an alternative form of positioning system, such as a radio-frequency

triangulation system, may be used within the scope of this invention.

Furthermore, it will be appreciated that the system, although described with reference to a Metropolitan area, is not limited to such an area. The system could equally well be adapted for use with emergency services, such as police  
5 and ambulance.

Claims

1. A system for control of a vehicle travelling along a predetermined  
5 route, comprising:  
a) a vehicle having:  
i) a first receiver for receiving position information identifying  
the position of the vehicle;  
ii) an input device for receiving timetabled information about  
10 the predetermined route;  
iii) means, responsive to the input device and the first receiver,  
for comparing the received position information with the timetabled  
information, for determining whether the vehicle is running to schedule and  
for generating a correction signal in the event that the vehicle is not running  
15 to schedule; and  
iv) a transmitter for transmitting the correction signal; and  
b) a traffic control device positioned on the predetermined route,  
comprising:  
i) a receiver for receiving correction signals; and  
20 ii) a controller, coupled to the receiver, for operational control of  
the traffic device in response to correction signals to re-schedule the vehicle  
to the timetabled information.
2. A system for control of a vehicle as claimed in claim 1, wherein the  
25 correction signal is transmitted when the vehicle is approaching and in  
proximity to the traffic control device.
3. A system for control of a vehicle as claimed in claim 1 or 2, wherein the  
correction signal is transmitted at a low power.  
30
4. A system for control of a vehicle as claimed in claim 1, 2 or 3, wherein:  
the system further comprises a central controller having: means for  
generating and transmitting interrogation signals to the vehicle; and receiver  
means for receiving signals transmitted from the vehicle;  
35 the vehicle further comprising:  
a second receiver responsive to the interrogation signals; and

means, coupled to the receiver, for generating an information signal containing time and location information for the vehicle;

wherein the transmitter transmits the information signal to the receiver means of the central controller, thereby providing the central  
5 controller with the time and location information.

5. A system for control of a vehicle as claimed in claim 4, wherein the central controller polls a plurality of vehicles with the interrogation signals.

10 6. A system for control of a vehicle as claimed in claim 4 or 5, wherein the correction signal and information signal are transmitted on a common channel at relatively low power and relatively high power respectively.

7. A system for control of a vehicle as claimed in any preceding claim,  
15 wherein the first receiver is a GPS receiver.

8. A system for control of a vehicle as claimed in any preceding claim, wherein the traffic control device is one of an automatic barrier, a bridge, a pedestrian crossing and a traffic light.

20 9. A system for control of a vehicle as claimed in any preceding claim, wherein the input device is a smartcard reader and the timetabled information is contained on a smartcard.

25 10. A vehicle having:

a) a receiver for receiving position information identifying the position of the vehicle;

b) an input device for receiving timetabled information about a predetermined route along which the vehicle is to travel;

30 c) means responsive to the input device and the receiver for comparing the received position information with the timetabled information, for determining whether the vehicle is running to schedule and for generating a correction signal in the event that the vehicle is not running to schedule; and

d) a transmitter for transmitting the correction signal to a traffic  
35 control device positioned on the predetermined route.

11. A vehicle as claimed in claim 10, wherein the correction signal is transmitted at a low power and in proximity to a traffic control device such that interference from the transmission of the correction signal is minimised.
- 5 12. A system for control of a vehicle travelling along a predetermined route substantially as described herein with reference to the accompanying drawings.
- 10 13. A vehicle substantially as described herein with reference to the accompanying drawings.

Patents Act 1977  
Examiner's report to the Comptroller under  
Section 17 (The Search Report) - 11 -

Application number  
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Relevant Technical fields

(i) UK CI (Edition L ) G4Q (QAB, QAJ)

(ii) Int CI (Edition 5 ) C08G

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner

M J DAVIS

Date of Search

22 SEPTEMBER 1993

Documents considered relevant following a search in respect of claims 1-13

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	None	

Category	Identity of document and relevant passages - 12 -	Relevant to claim(s)

### Cat gories of documents

**X:** Document indicating lack of novelty or of inventive step.

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